

# Digital radiology at Norwegian hospitals

*A single-case study of the influence that the  
incorporation of digital management of  
radiological examination has provided in the  
working day of doctors*

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# Summary

Digital radiology has been implemented in most hospitals in Norway during a ten year period beginning in 1999. Radiological examinations have become an indivisible part of health care including specialist services. After the transition from radiological images on film from their digital edition, the results of various radiological examinations have come so close to the physicians as a few keystrokes on a computer. The availability and quality of the images has increased markedly.

This explorative case study aims to investigate how the introduction and use of digital radiology affected the daily lives of physicians by looking closely at the working day of the physicians in a department of a Norwegian hospital.

The theoretical framework of the thesis consists of organisational theory with a focus on the organisations' formal and informal elements. The thesis is empirically based and a single case study, and there were conducted an observation of the specialists' work and in depth interviews with the department's physicians.

The main findings show good correlation between the empirical data and theory. It is easier and faster to influence the formal than the informal in an organisation, including the physicians' culture and behaviour.

- Very little change has occurred in the way the physicians work is built up.
- Digital culture among physicians is developing.
- Internal power relations are about to change. Those responsible for the technical management are gaining control and power over the tools that physicians use in their working day.

# Acknowledgements

Writing this thesis has been an exciting and long journey to a country I have read extensively about, but never visited. I learned a lot and discovered even more. This research would not have been possible without my informants that allowed me to take part in their working day and setting up interviews with them. Thank you for your trust, time and information.

My supervisor, Associate Professor, Lars Erik Kjekshus has been a source of inspiration, support and guidance. The whole process, from choosing research questions to finishing the last sentence happened due to his keen guidance. Thank you.

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My dear Oddgeir, thank you for the support, time and patience. We made it!

May 2014, Norway

Julia Lützen

# Acronyms

|      |  |
|------|--|
| CT   | Computed Tomography                      |
| MRI  | Magnetic Resonance Imaging               |
| PET  | Positron Emission Tomography             |
| PACS | Picture Archive and Communication System |
| EPJ  | Electronic Patient Journal               |
| NSD  | Norwegian Social Science Data Service    |

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# 1 Introduction

Imagine a camera where you have to put a coil of film in a dark room. When you are taking pictures, you cannot see what was really caught on film, and if the quality is adequate before you have developed the film, either by delivering it to a business that specializes in developing or by developing them yourself in a dark room.

It was quite similar in hospitals, regarding radiology-images of a body-part. The radiology-machines are much larger than a camera of course, and produce X-rays that passes through the body completely, partially or at a small degree. The rays that pass through the body are captured on a special plate of film and you needed professionals using special chemicals solutions in order to develop the film, called a radiograph. Doctors use these images of different body-parts as an aid in the study and treatment process at almost every hospital in the world.

Then, imagine a digital camera with a wide array of settings that allows you to view the finished picture immediately. You download the images onto a computer and you can share them with family and friends by sending them an email, store them on a CD, on a digital photo-frame, printed or whatever you prefer.

At Norwegian hospitals radiologists and specialists can view a radiology-image almost immediately after it is taken using a computer with special programs. This is now a part of the working day for doctors at most hospitals in Norway. There is no longer a need to have physical image at hand following the patient around. Most hospitals here in Norway have started to use this new technology in radiology and for a large proportion of them this is their only source for images of the various radiological examinations.

This revolutionary step started to appear in the Norwegian health care system from the year 1999 and onward. Four years later 78% of the Norwegian hospitals had started using this new technology within radiology. In 2009, this percentage had risen to 93%, and 5% of the hospitals had started to establish a digital image archive. (Kjekshus&Bernstrøm, 2009, p. 39)

Back to the old-fashioned film camera and the modern digital camera. What does it require of us as individuals in order to learn and maybe even adapt our habits in order to use this new tool? The same kind of question could be asked of the hospital as an organisation. How does

the introduction and implementation of new technologies affect a Norwegian hospital? I feel that this subject is an interesting one, but also complex. There was a need to choose a specific area I could research and a specific issue I could answer. I received great help to do this from my supervisor Lars Erik Kjekshus. We jointly prepared the projects theme and chose a theoretical approach and the procedure to find answers to the set questions.

Defined Research Questions:

How does the incorporation of digital management of X-ray, CT and MRI influence the working day of doctors in the Norwegian hospital as an organisation?

- 1) Does the introduction and use of digital radiology induce the need for a change in work schedule/routine for the doctors and the hospital in general? Why?
- 2) How did the use of digital radiology change the situation linked to management, control and coordination on a day to day basis for the hospital doctors?
- 3) In what way has the organisational culture contributed to the current structure of their working day?
- 4) How has the behaviour pattern of the doctors changed as a result of the transition to digitised radiology at the hospital?

The answers to these questions require knowledge of both concepts and historical data in the Norwegian health care system. These are found in the section “Facts and terms”. There you will find the results of other people’s research that is both relevant and has similarities with the findings in my own study. Furthermore, I will describe the constraints and limitations of this study. The account of methodological and theoretical approaches is described in their own chapters. There will be a particular focus on presenting the findings in chapter 6. The findings will be discussed and analysed in the chapter 7. The thesis will be concluded with a summary.

## 2 Facts and terms

There are a number of studies looking into the introduction and use of various technologies in the Norwegian health care system, at different angles. For instance INTORG 2009 studies (Kjekshus&Bernstrøm, 2009), by presenting statistical material collected in tables, and including a positive development pattern associated with the introduction and use of electronic medical records and radiological image archives in Norwegian hospitals in the period of 1999-2009.

In their article Jan-Tore Lium, Aksel Tjora and Arild Faxvaag describes the effect the introduction and use of electronic medical records had on the routines of physicians in two Norwegian hospitals. “No paper, but the same routines” is their conclusion (Lium, Tjora &Faxvaag, 2008).

In his research, “Caring Machines”, Aksel Tjora examines the “emerging practices and coordination in the use of medical emergency communication technology in Norwegian emergency medical communication centres” (Tjora, 1997)

The first study shows that digital radiology has been implemented in Norwegian hospitals during the ten-year period. The last two studies provide an explanation as to what effect a new technology has had on healthcare professionals and their work. These findings have many similarities with the results of my survey even though it is about a different technology. The daily work plan is the same as before the introduction of digital radiology. There are still some nuances that I am going to shed light on in the analysis chapter.

Furthermore, this chapter explains various terms that I will use further in the text.

### 2.1 Radiology

Radiology is a medical speciality that employs the use of imaging to both diagnose and to treat diseases visualised within the human body. Radiologists use an array of imaging technologies such as X-ray radiography, ultrasound, computed tomography (CT), nuclear medicine, positron emission tomography (PET) and magnetic resonance imaging (MRI) (Store Medisinske Leksikon, 2014). For further explanation, you can among other sources of information look it up in The Large Medical Encyclopaedia.

## **2.2 Radiologist**

Radiologists are physicians specialising in the field of radiology. The radiologist analyses the images and provides feedback about diagnosis or recommend further examination of the patient to the clinic and ordering physician, either routinely or emergently.

(www.utdanning.no 2014)

## **2.3 Digital radiology**

The term digital radiology I use to denote all new technology within radiology at Norwegian hospitals. It involves digital image displays, electronic image archive, teleradiology etc.

## **2.4 Peculiarities regarding the use of images on film**

Before the introduction of the new technology, all radiological images were printed on a piece of varying size of film. The special limitation with radiological images on film is that as a rule there is only made one development of each image. Therefore, when an image was to be studied during meetings, examinations, doctors' visits or other tasks, it was not available to another physician or another meeting. During an examination of an image, a doctor would use a light-shield and use other tools, i.e. lineal for measurement of distance and size of different areas. The recurrent use of X-ray photography on film reduces the quality, which in turn reduces the diagnostic value of the image. In addition, you have the risk of losing the image in transition, or just that the department forgets to return the image to the radiology department that stores all X-ray images on film.

## **2.5 Electronic patient journal**

Electronic patient journal, or EPJ, is an electronic collection/compilation of recorded/registered information about a patient in connection with health care at a specific hospital. The collection of data that make up a patient's EPJ in a hospital, is not necessarily handled by a single EPJ system. It will often be a case that in addition to the information in the general EPJ system's data, there will also be data from several specialised systems included in the patient's EPJ (Helsedirektoratet/ KITH, 2014).

## **2.6 PACS**

PACS stands for Picture Archive and Communication System, and is a term used for digital radiography. The radiographs are generated, stored and distributed digitally in the PACS, and there are not any need of film and image development any longer (Helsedirektoratet/ KITH, 2014).

### **3 Constraints and limitations of the study**

This study will be almost exclusively on physicians in one department, their working life and perception of the situation related to any implementation and use of digital radiology at the hospital they work at. The management's perspective on the matter will not be discussed in this paper, nor will the opinions of patients, internal or external actors the hospital interacts with, be taken into consideration.

# 4 Research Methodology

## 4.1 Case study

The issue at hand qualifies to be examined using methods within qualitative researching. Both the main and underlying questions start from queries type: “How; which; what and why.” According to Kumar, answering these questions, the focal point will be, “on extensively exploring and understanding rather than conforming and quantifying.” (Kumar, 2011, p.127). Gudmundsdottir, which states, “The purpose with all qualitative studies is to develop a thinking tool, texts that can invite to discussion, by that develop and better the practice in similar settings” (Postholm, 2005, p. 108), supports this set of thinking.

The study is retrospective as it is about events that already happened. Furthermore the study fills the demands for it to be called a case study due to the collection of data which was limited in both time and space.

The information I gathered was from the primary sources, i.e. the doctors from one of the wards at the Oslo university hospital. I chose a ward where radiological examinations were performed frequently.

The use of secondary sources, such as adjudications and working through published articles were necessary in order to give a thorough image of the historical events regarding the technological development of the hospital.

## 4.2 The strategies of data collection

Contacts with the doctors were performed in two different sets. First, I would observe the doctors in the course of a normal working day, a so-called “non-participant observer”. I would not get involved in any activities of the group, but remain a passive observer, watching and listening to the activities and draw conclusions from this (Kumar, 2011, p. 140 – 141). This also makes it possible to ask the doctors directly about their experiences and their thoughts about the use of digital radiology during their working hours. Second, I decided that I would talk to the doctors by means of interviewing them. The semi-structured in-depth interviews would be of great assistance in order to reach the determined goal. In order to

achieve this I constructed a research instrument in the form of an interview guide. I outlined a line of thematic questions in this interview-guide (Appendix I I), which would help me to open up the conversation and get the interviewees to shed light on this particular subject. The interview had to be semi-structured in order to make it possible to ask follow-up questions which in turn would penetrate deeper into the subject. The benefit with this type of interviews is that the persons interviewed have greater freedom to speak broadly about the subject using his/her knowledge, experience, feelings and opinions. In addition, it creates an opportunity to identify themes and conditions that were not initially put as questions in the guide. The researcher also gets a better opportunity to observe the interviewed person during the interview. Body language, facial expression, the pitch of voice as well as what additional information the person wants to talk about, provides valuable information for the researcher and is not to be underestimated.

Furthermore, there was a need to analyse the interviewees available to find out whom of available specialists would cover the information I needed for answering the questions. Since the theme of my thesis included the use of digital radiology on a day-to-day basis and the usage of radiology before the digitalization era, it had to be doctors that had experience using both systems. To begin with, I needed a doctor in an administrative position, Senior Consultant and a Junior Registrar. A specialist with at least five years or more of experience occupies the position of Chief / Head Senior Consultant. The title of Senior Consultant is something a doctor can obtain after a period of five years of specialization. After a newly educated doctor has finished with his practice internship, he starts out in the hospital as a Junior Registrar. The information provided by the senior doctors, covered a period of at least ten to fifteen years. This was sufficient as the historical data confirms that the digitalization of radiology started ten years ago (Kjekshus&Bernstrøm, 2009; Helse- og omsorgsdepartementet, 1996).

By using the snowball-method, I came into touch with three specialists at a ward, willing to participate in interviews. At the same time, I could make an appointment for a day of observation at the ward.

I sent an email to the interview subjects with the following information: a comprehensive description of my project, an interview-guide (Appendix II) and anonymity information (Appendix I), the usage of audio-recording device during the interview, the handling of the



audio file and the option to withdraw from the study at any time, even after conclusion of the interview. All three interviewees gave their informed, voluntary consent for an interview.

The language during the interviews was Norwegian, and all written and oral information was in Norwegian as well.

The gathered information during the interview with these three specialists would be paramount in deciding if there would be need for additional interviews and days of observation. After the third interview, I saw no further need for additional interviews. All three subjects described in their own words, with a little variation, the same picture of the daily routines at the ward. Thus, the saturation criteria for the qualitative approach were fulfilled. The data gathered from the field of observation, supported the information from the subjects.

Observation notes were transcribed immediately after observation.

I conducted the three interviews the following days after visiting the ward for observation. I made no written notes during the interviews as I decided to make use of an audio-recorder. The interviewees did not talk or discuss the theme of the interview after the recorder was turned off. The transcription was done as accurately as possible without the analysis of the vocal range, pauses or emotions included if that was not regarded as a crucial part of the information.

The whole set of data, consisting of the notes from the day of observation and the transcriptions from the interviews were thoroughly checked and if needed corrected with the focus of anonymity regarding the field of research, names and supplementary direct and indirect person-identifying information (Postholm, 2005, ch.8-9).

After making the decision to not continue with any more interviews, I started working on the theoretical analysis. I will discuss the theoretical approach in the next chapter and then show the application of the theories in the chapter "Analysis".

### 4.3 Quality in a qualitative study

There are different views on the relationships between researcher and research participants that is the most appropriate to ensure the quality of research (Postholm, 2005, p. 141). Some are sceptical of research when the researcher is familiar with the field of research, such as described by Glesne and Peshkin (1992) in Postholm, 2005, p. 140. Others support such a relationship. Among them Hammersly and Atkinson (1996) (Postholm, 2005, p. 141) that believes that it is necessary to know the culture of a group in order to provide credible explanations for the actions of their members.

I would like to explain how my own background could influence the research.

I have a close connection to the medical profession as I trained to be a Medical Doctor and I have worked in the Norwegian healthcare system. This background I found to be very helpful in this study. It made the medical terms and lingo both during observation and interviews, clear and understandable. It helped me as well to make and ask precise questions for the case interviews. The gathering of interview subjects went quite easily, and during the interviews, the subjects seemed to feel that I was one of them and as such, could talk more openly about the theme for my study. During the interviews, I was subtly reminding the subjects that I was in fact now a researcher and not one of their colleagues, and that I needed their experiences and knowledge about my topic of study. I did this by asking follow-up questions.

On the other hand, my knowledge of the routines for the doctors at Norwegian hospitals forced me to keep an enhanced focus during my observations. I wrote down all details during the observations, which revealed some additional information that I would not have noticed if I were there as a physician. Both the main and follow-up questions for the interviews were pointed towards getting the subjects opinions, experience and views. I can therefore say that I used my medical background as a resource in gathering the necessary data for my thesis. Diligently usage of literature about qualitative research-methods helped me bring in nuances and particularities that I otherwise always have taken for granted due my insight in the working routines of physicians in general. All in all I think that my medical background as well as the versatile practice in the Norwegian health care system was of great benefit to this study and has helped strengthening the study's validity and vitality.

It is important to note that the researcher, who uses a qualitative research approach, will in their research tell stories where the researchers' and participants' perspective and voices merge together (Postholm, 2005, p. 130).

To ensure the quality of the research process, I performed the following procedures.

I used several data-collection strategies such as interviews, observation and documentation review. The data was analysed using organizational theory. This process is called triangulation. It means that data are collected from multiple sources and if they support each other, they will strengthen the study and ensure reliability (dependability) (Postholm, 2005, p. 132). It provides as well, the ability to create detailed descriptions of the research field and facilitate naturalistic generalizations about the usefulness of the research findings (Postholm, 2005, p. 131-132).

I conducted personal interviews. The allotted time can be considered adequate. Questions in the interview guide were tested against the reports' main and sub-questions. It was perceived that the answers to these questions would help clarify the chosen topic. The same guide was used during all three interviews without change since the first person interviewed, nor the two following, came up with new themes or angles of the main topic that would require adjustment of the interview guide. I nevertheless asked different additional questions to each subject as there was a need for explanation, clarification or if the subject strayed from the study topic.

After I finished the transcribing, I did not send a copy to the subjects for validation, so-called member checking. On one hand, this can be considered as a disadvantage towards the quality of the study, since the researcher will not get the confirmation from the subject that the information conveyed during the interview was perceived and interpreted correctly. On the other hand, the use of audio recorder and speedy transcription minimized the risk of misinterpreting the information gathered. In addition, the answers from the subjects corroborated with the findings I made during observation.

## 4.4 Ethical guidelines

Ethical guidelines were followed throughout the research process. The project was approved by the Norwegian Social Science Data Service (NSD).<sup>1</sup> This approval means that the research is conducted according to the Personal Data Act in Norway.

### 4.4.1 Prior to collecting data

Ethical aspects were also taken care of by giving oral information to the subjects about the project. The goals, the way the gathered information and data would be presented, what would happen to the recordings and notes when the project finished, how anonymity would be achieved, and the opportunity to withdraw from the study, before start, during, and after data collection. The same information was given to the Head Senior Consultant for the main observation in order to get permission to perform the observation.

All subjects gave an informed, voluntary consent. All physicians that were on the staff meeting when I presented my project provided a verbal consent. All information mentioned above was repeated to my interviewees once more before start-up of the interview. It was important for me to build up trust between myself as a researcher and all participants, both during the observation and the interviews.

### 4.4.2 During data collection

In order to make the observation feasible, I had to sign a declaration of confidentiality and organize an admission card. On the day of observation, I chose to equip myself with a hospital uniform, consisting of a white shirt and white trousers. The coat is only used by physicians. By having put on the uniform and pinning the admission card to it, I showed all staff there that the formalities were in order and that I had clearance to be there. The similarity in clothing also made it possible for me to blend in so the focus of the staff would remain on their duties, and not on the person observing. That is how I tried to be considerate towards the participants' values, interests and maintaining trust (Postholm, 2005, p.148), which I felt was formed at the first meeting.

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<sup>1</sup> NSD is the Data Protection Official for Research for all the Norwegian universities, university colleges and several hospitals and research institutes. URL: <http://www.nsd.uib.no/nsd/english/pvo.html>

All three interviews were conducted at the hospital. I informed each subject of the study about the secure handling of all data collected before and during interviews. The audio-recorder did not hinder the subjects noticeably during the interview; however, I decided to put it outside their field of vision. All three were a bit tense at the beginning of the conversation, visible through the formal tone, wording and body language. After my introduction, the subject became more relaxed; in my opinion, talked freely, and wanted to pass on any information they had about the project.

The interviews were conducted so that the persons were in focus throughout the conversation, my role was to listen and ask open questions. When I was unsure if I had understood the person, I asked one or more clarifying questions.

#### **4.4.3 After collecting data**

It is vital to protect the interests of the participants in the study after the completion of the study, and as Postholm says, “Give them something in return for their participation in the study” (Postholm, 2005, ch.8). The three interviewees were interested in reading my master thesis when it is published and showed that they to some extent were available for assistance during my work with the data. With great appreciation and respect for my interviewees understanding their busy work schedule, I decided to send them an email with the link to the already published paper.

# 5 Theoretical Framework

The organisational theory as Jacobsen and Thorsvik presents it in their book (Jacobsen&Thorsvik, 2007), seemed a natural choice in order to explain the organisational changes after the implementation, and use of digitised radiology that I observed and were explained by the physicians. In addition I feel there is a correlation between March's theory on competency traps and the absence of needs and initiative with the physicians to change the proven and functioning methods used in their work at the hospital. Kjell Arne Røviks' designation of a hospital as a "multi-standard organisation" helps one understand that a hospital is a large and complex organisation with a distinctive way of changing.

I will start the account of the theoretical approach by explaining what a "multi-standard organisation" is, then I will sketch the main elements in the organisational theory and at last I will go through March's theory around competency traps.

## 5.1 Hospital as multi-standard organization

Hospital as an organisation is best described using Kjell Arne Røviks' term, "multi-standard organisation" which means: "The typical multi-standard organisation is a large, modern enterprise, such as a hospital (...), which over time has adopted many popular organisational procedures. Analysed at a particular time, it will emerge as a relatively loose collection of many components or institutional standards (...) adopted fairly uncoordinated – often by different actors – in different periods and different parts of the environment" (Jacobsen&Thorsvik, 2007, p. 359).

This particular way of looking at the hospital makes it easier to understand that this organisation changed as a whole, rather than slowly over time. There may be changes in individual departments and some units may be aware of the first-mentioned changes but continues its work as before (Jacobsen&Thorsvik, 2007, p.359). This complexity does not provide the ability to make quick conclusions regarding the hospital organisation as a whole.

## 5.2 Organisational theory

Every organisation is a social system that is deliberately designed to solve specific tasks and achieve specific goals (Jacobsen&Thorsvik, 2007, p.13). For an organization to function it must have written goals, strategies and a formal organizational structure that forms the formalistic element (Jacobsen&Thorsvik, 2007, p. 16). It provides the framework regarding the organizations' direction and how it ideally should be achieved. An organization is a social system and with this, an informal element enters the picture that makes the organization complete. Within this element, the organizational culture and power structure requires a special explanation.

According to Jacobsen and Thorsvik, organisational culture consists of values, group norms, social cohesion, peer pressure and ethical guidelines for what is good and proper behaviour within the organisation (Jacobsen&Thorsvik, 2007, p. 17). Moreover, the authors describe the organizations relations of power as individual and the clusters within have personal goals are linked to the groups own interests (Jacobsen&Thorsvik, 2007, p.17). I.e. a physician's self-interest for research can be in contradiction to the treatment strategy the hospital he works for have chosen, or that a group of nurses at a department prioritizes social and professional contact with their patients rather than closely logging their work, which would be more in line with the priority policies a hospital has.

One can compare the two main elements to an iceberg as I chose to show as a triangle (Figure 1).

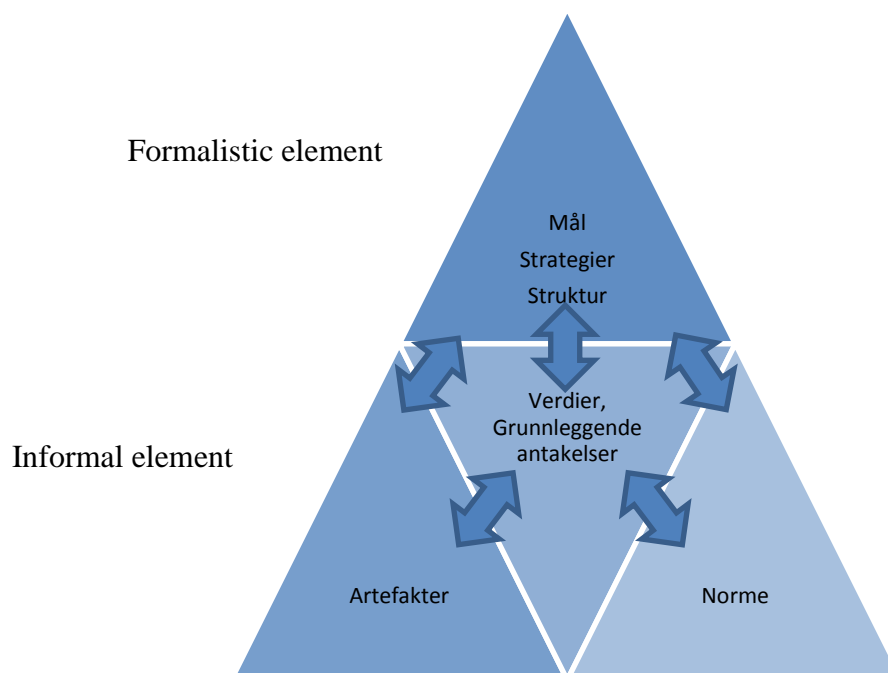


Figure 1: Schematic model of organisation. The main elements and relations between them.

The part that is visible above water is a small fraction of the whole iceberg. Similarly, there tends to be quite clear how an organisation is structured and what it wants to achieve. In the figure, the top triangle symbolises the top of the iceberg and consists of goals, strategies and organisational structure. One must spend a lot of time, dive deep as it were, to get familiar with the organisations' culture and the values the employees have and reach an understanding of "how they do it here in their house" (Jacobsen&Thorsvik, 2007, p. 17). The three lower triangles in figure 1 represent the part of the iceberg that is submerged. Artefacts are easy to observe, but can be difficult to understand. They consist of what employees say, their behaviour and the material, created by humans such as, uniforms, interiors and architecture. (Jacobsen&Thorsvik, 2007, p. 126-128). Jacobsen and Thorsvik (Jacobsen&Thorsvik, 2007, p. 125) cites Scheins definition of values, which means that they have taken a conscious decision that something is good and something else is bad. Such a world of interpretation often follows a natural form of the basic assumptions we have. While values are abstract ideals, norms are "certain principals or unwritten rules that humans are expected to follow" (Jacobsen&Thorsvik, 2007, p. 125).

A medical ward at a hospital can be considered as an organisation in miniature. It has its formal structure that consists of management, department physicians, nurses, nursing



assistants, medical secretaries and a number of other people with or without medical training. The written goals and strategies have their peculiarities depending on what department one is looking at. Every department has its own culture with several sub-cultures. Accordingly, I use four groups of organisational components that may be affected by a change, to analyse whether the change is true or not in the department that I studied.

### **5.2.1 Tasks, technology and/or goals and strategy**

This may mean that an organisation can define new strategies and fine-tune their goals. The routine of how a task is performed can be changed both independently and because of other changes. The same applies to the implementation and use of new technologies (Jacobsen&Thorsvik, 2007, p 351).

Here I expected to observe that doctors used the digital solutions in radiology in their daily routines without the need for radiological images on film. This has been and still is the goal of both the state (Helsedirektoratet/KITH, 2005, Helse- og omsorgsdepartementet, 1996), and the hospital and in this way the goal of the department. For me it seemed that this was the largest change in the physician's working day. No chance to go back to the previous way of operations no matter what a physician may feel about the matter.

### **5.2.2 Organisational structure**

This consists of a new way to distribute and coordinate tasks, a different way of managing and controlling the organisation. (Jacobsen&Thorsvik, 2007, p. 352)

In my opinion, the empirical data will clarify how the coordination of image flow occurs. The main control is placed with the physicians. They have full access from any hospital computer. On the other hand they have become dependent on IT support in case of computer or software failure. This type of dependency makes the physicians more vulnerable compared to the situation before the new technology was introduced. Then, the medical secretaries performed most of the work related to the flow of radiological images from the radiology department and back. If the secretary forgot to bring a picture, even worse, misplace a picture, the physician could order a new image-capture and proceed. Now in the present time, if the software or computer-system fails, the doctors have no control or influence over the

situation. They have neither access to radiology images or descriptions until the IT personnel repairs the problem(s).

### **5.2.3 The organisations' culture**

The term covers the basic assumptions, norms and values (Jacobsen&Thorsvik, 2007, p. 352).

Since organisational culture is about the unwritten procedures that employees who have worked for a while in the department knows, it was not that easy for me to draw any firm conclusions from the study material. I did think however, that my medical background would be of great help.

It is not easy to influence a culture and there are several reasons for this. It consists of the unwritten, as in this case, everyone who works in the department knows the culture, but someone from the outside would have little knowledge of it. The physicians culture is something that a doctors starts to build at the university. In a way, they are among a selected few that are going to master the medical art and use it to save lives. They have devoted a large part of their life to their profession and get great respect from both colleagues that are not physicians and the public in general for the vast, lifelong work they do. As a profession, they have great mutual affiliation combined with distinctive cultural attributes, depending on what specialisation or expertise they possess. They act mostly by a paternalistic pattern because of their profession, which in turn imposes the responsibility for the health and lives of the physicians' patients.

The lifelong education and responsibility require from the physicians as a profession that they must continue to keep updated on the new developments in the medical world. They maintain at the same time the second part of their medical profession almost unchanged that gives a feeling of mastery and safety both for themselves and the patients.

All of the above are relevant to the cultural changes that I managed to ascertain for the short stay at the ward. It gives reason to believe that the amount of change in the routine of the doctors on the ward may be due to the slow changes in department culture and especially the culture of doctors as a profession. Here one can sense the signs of a resistance to change. Reasons for this may be a demand after new investments. It means that change in an organisation may claim employees to acquire new knowledge and skills. As a result, some

have to get back to school or take courses to be able to continue in the same position as before (Jacobsen&Thorsvik, 2007, p. 361-364). One may assume that a duplication of effort could stagnate innovation regarding the structure of the physician's working day. Until the new organisational solution was in place, it entailed that employees often would have to do their work both the "old" and "new" way. This means that the physicians had to work with images on both film and digital. As the old radiographic images got phased out, it made it harder to obtain the digital images of patients that came for treatment or examinations from other hospitals.

#### **5.2.4 Behavioural processes**

This refers to the change of production, communication, decision-making, learning and internal power (Jacobsen&Thorsvik, 2007, p. 352).

One could be led to believe that the total, subject to technical failure, availability of results of various digitised radiological examinations, would lead to greater patient circulation, improve diagnosis and treatment quality and making it easier for the physicians. I suppose that this might partly be the case. It is important to make a reservation towards the effectiveness being a result of the implementation of several new technologies, such as EPJ. The electronic medical records are like a door for a specialist at the ward, that he/she must open in order to access the image archive. This makes it harder to distinguish the cause and consequence relationship that applies to digital radiology solely in the daily lives of the hospitals' physicians. This means that the routines a physician follows depends on other factors, including EPJ, as working tools. The way I interpret Jacobsen and Thorsviks production as a part of the behavioural processes, it is not possible to say unambiguously whether it was affected because of digital radiology, EPJ, a combination of the two or even multiple new technologies.

The absence of significant change in communication, decision-making and learning as components of behavioural processes (as I understand it), is made visible in the preservation of radiology meetings taking place almost the same way as it did prior to the implementation of digital radiology. In addition, I sensed that a fear of losing the social, (Jacobsen&Thorsvik, 2007, p. 361-364) and professional ties to their colleagues in the radiology department was one of the reasons that the department continues to hold these radiology meetings.

The total availability of the results of radiological examinations in an electronic format has in my opinion strengthened the physicians' position and has as well influenced the internal power relations. This impact has its Achilles heel in the form of technical failure which I expect to hear from the physicians during the interviews.

## **5.3 Competency traps**

Before I conclude the chapter on theoretical framework, I will explain March's view of one of the effects of organisational adaptation called "competency traps" (March, 1994, p. 96). This phenomenon can occur in different forms under different contexts during the change-process in an organisation. It is about the relationship between the existing routine, technologies, strategy and/or practice, and a new, potentially better one, but that the decision-makers have little knowledge of (March, 1994, p. 96).

According to March, when an organisation uses such a set of routines, their employees know by experience what routines should be used when and how, and gradually they learn what changes are needed in order to make that specific routine even better. The more the individual routine is used, the better the persons become in performing the task. This increases the probability of choosing the same routine to solve similar problems that arises, since they have extensive experience with this particular routine. Individuals, departments and organisations thus become specialised as a part of the natural learning curve. This can result in a competency trap both at the individual level, and at different levels of an organisation or a society. Individuals and organisations are so engrossed in their speciality and therefore exclude a potential better course of action (March, 1994, p. 96-97).

Furthermore, I present a description of the material that was collected during the observation and interviews. Then, the theoretical approach presented in this chapter will be used to analyse all findings in order to gain a deeper understanding of the research field.

## **6 Study findings**

### **6.1 My impression around the observation and interviews**

#### **6.1.1 Observation**

During the observation, it seemed that doctors and other health care professionals work such that they would normally do without the presence of external people like me. I was asked several times, about “whom I were” and “what I did on the ward”, but I had the impression that I was welcome on the ward. The doctors continued to do their tasks, but they were also open to questions from my side. They told quite often themselves what will happen next in their daily routine, why they do one procedure then an another, etc. without me having to ask about it. It seemed as if they were used to it.

During the observation day, it was a sense of normal daily working atmosphere in the hospital and on the ward. It was intense, at times even a bit hectic, yet in some way too relaxed as well, or, in other words, to some extent routinized when everyone knows when, how and what to do.

I wore white hospital clothes not to look different from other health care professionals or medical students. I think it was very important to have such clothes during the observation, as it felt more natural for everyone around me as if I was a part of their working environment. In this way, I would also show respect to healthcare professionals so that the focus should not be changed from their work to a stranger who observes them.

#### **6.1.2 Interviews**

The three interviews were conducted at the hospital and the interviewees showed up precisely on time. There were however interruptions by pagers, mobile phones or hospital staff very often. These interruptions did not influence the good disposition I felt during the interviews. It seemed that the interviewees had no barriers talking to me. Quite the opposite, they saw my study and me as an opportunity to voice their thoughts, experiences and opinions about the use of the hospitals IT solutions during their working day. They also shared their frustrations

and resignation on the subject of their opinions as they were not being asked or heard regarding the various choices made when it came to patient-administrative systems.

## **6.2 What they do, how they do it and what they think about it or main study findings**

The working day for the physicians starts at 08:00 at the department of Radiology and Nuclear Medicine, or more commonly called the X-ray department. The day starts with what the doctors call “the X-ray meeting”. One must be very familiar with the hospital's geography to reach a destination right on time. The meeting room was dimly lit, relatively little, sparsely furnished with chairs that were placed in three long rows and directed towards two large white screens on the wall. The radiologist sat in the corner behind a table equipped with three computer monitors. Usually a radiologist leads the radiology meeting. Even if it is early in the morning, the meeting is dynamic. Displaying of images is mixed with academic discussions between physicians and radiologist, questions from the junior physicians and the exchange of clinical experience and radiological diagnostic knowledge between the physicians and radiologist.

The radiologist uses a projector to exhibit the digital images. If necessary it displayed two images for comparison on each screen, enlarged or reduced, with changed brightness and sharpness, displayed focus picture of discovery, performed various measurements of different formations. When it was shown CT and MR images and results of ultrasound examinations, it was possible to see the results as a small film, play it in slow motion and then watched the cut for cut where necessary. The radiologist could set the colour or mark in certain areas she felt were of interest to the doctors.

In addition to the high-tech examination method-imagery the radiologist showed with each image, the scanned requisition forms that the physicians had filled out and stamped by hand. The interviewees confirmed that the requisition forms still used are in a paper format that the physician's secretaries deliver to the radiology department. This is still the only way to order a radiological exam.

The radiology meeting was concluded 45 minutes after it started, and the physicians went back to their ward and started their department meeting. The meeting mainly consisted of oral reports from the physicians on duty last night and morning and was led by the chief.

During the meeting, there were a few questions about some patients. These were quickly resolved, as one of the doctors signed into the electronic medical records and found the relevant information and digital images by using the computer available in the room.

Approximately, at 9:15, the staff meeting was concluded and some doctors went to the outpatient clinic while the other doctors prepared to be ready for pre-visit.

At the out-patient clinic, patients arrive at a half-hour interval. Before the patient arrives at the clinic, he has already been to the radiology department and taken the prescribed examination. This ensures that the physician has the image in the database when the patient arrives. These consultations are mainly used for controlling the state of a patient's disease. Earlier, when film was being used, the schedule for the patient was more or less the same. The main difference was that he had to take the developed image with him over to the outpatient Clinic and give it to the doctor. He then examined the image on a light screen.

The physicians that were starting their pre-visit went to the medical room, which was furnished with four large office desks. On each desk were two PC monitors, keyboard, microphone connected to a computer and a few books including diagnostic and procedure codes. There were placed dispensers on the walls and tables with different paper forms for requisition of tests and other forms.

During the pre-visit, the doctors in collaboration with the nurses went through each patient at the department. They combined the use of a computer for viewing images, results of different blood samples, journal notes and a folder named "Kardex". This folder is a paper based register over all patients admitted at the ward. This holds an overview over the current daily measurements such as blood pressure, body temperature, etc. for each patient.

The specialists must first log onto their computer and open the electronic patient journal, EPJ, in order to view the digital images,. Every doctor at the hospital has access to images and all written information about their patients. The other option is to log onto the electronic archive. At this point, only the radiologists have access to this archive due to the limited number of software-licenses acquired.

The image quality of the digital radiology images compared to the film, has improved significantly and it does not deteriorate. It is mentioned that EPJ, is used up to twenty times a day. This means that a doctor views both a high number of images and views a single image

multiple times each day. He or she has the opportunity to gather missing clinical information with the patient, for then to go over the findings again, both image and its description by the radiologist. The specialists think that the constant availability of the digital images, gives a qualitative reward when it comes to understanding, learning and diagnostics.

During the pre-visit the computer system worked somewhat slowly. The doctors had to wait patiently for several minutes to download the current X-ray picture. Otherwise, it went quite well working with the electronic records when it came to find the notes about the patients, test results and most radiographs.

When both doctors and nurses were updated on their patients' status, they began the visiting round. While the physicians talked with the patients and to the nurse, all of the notes are available on paper sheets or in the Kardex. Computers are not available at the patient rooms or in the hallways.

After the visiting round, the doctors returned to the doctor's room. They began with so-called paperwork and administrative work until they have their lunch break, and continue doing this until the end of the day. The work consists of finishing writing today's patient notes, discharging summaries, prescriptions, completing requisition forms, receiving emergency and elective patients and again, documenting their findings of examined patients, writing notes of any patient examinations and treatment plans, perform diagnostic procedures.

They logged onto their computers in their shared office and started writing notes and discharge summaries by using EPJ. They looked at old notes, different test results and checked radiological images. They read the image descriptions, studied the X-ray pictures and adjusted them in order to get the best insight. They measured the infiltrations, discussed their patients with the colleagues in the room, and spent some time to make calls to the radiology department and the laboratories.

During lunch, the department physicians gather in a room equipped with a large computer-screen, computer and office desks. In this room they tend to have classes and video conferences. , They appeared to also frequently use the computer and the monitor for video conferences while looking up information on some patients when they discuss a diagnosis or treatment strategy. They look together at the notes in the electronic record, test results and X-rays.



Two of my three interview-subjects had previous experience with the old radiology images. So they could describe the implementation and use of digital radiology as a relief when it came to the access to the images. As a result of easy access, the images are viewed and consulted more often. In addition, the option of having the radiologist on the phone, viewing the same image/s, is a massive relief and makes the work easier as it is less need to go over to the radiology department to consult with the radiologist. The distances between departments and wards are quite long at the hospital.

The interview-subjects that had experience with the use of developed images, thinks that the routines as such were not changed much at the ward. At the same time they feel and think that the administrative duties a doctor must perform has increased. The answers to the question “a need for change” in connection to the implementation and use of digital radiology was rather unambiguously. The subjects were hard pressed in seeing the need for great change or envision of less change in their working day due to the use of digital radiology. They felt that it were not relevant and actual for them. The administration on the other hand could feel that the radiology meetings were obsolete since each doctor now has every image at hand through the computer. This view ended up with a suggestion to drop the radiology meetings by the administration, but was turned down by the academic environment at the hospital.

It is added instantly, that it has been and still is, a bit of frustration concerning the software. Earlier the subjects experienced “down-time” at least once a week, in addition to it being slow and “choppy”. Now it seems to be at a higher level of function, with “down-time” about once a month. It was pointed out that one remembered the times the programs did not work much better than when it ran as it should.

All three subjects told me about their use of the hospitals patient-administrative systems. The aspects of EPJ with a development-potential had a particular focus. Among the things mentioned as being problematic was the problem they had changing between the writing page, the pages with test results, and the journal itself. They taught themselves different tricks in order to use all these pages at once, but often the system could not handle the load this puts on it and could stop working for hours. The subjects saw this as discouraging especially during poly-clinical work. It is possible to switch between digital image-viewing, test results whilst dictating notes with the use of voice-recognition at the same time. The last has its own challenges that will not be discussed in this thesis.

The subjects inform that they earlier could use two screens in their office. The thought behind the two screens were that one viewed the digital images on one screen and works in the EPJ on the other, or view test result while writing discharge summaries. Nowadays only one screen is made available for office use. The IT-department was given notice when the screens stopped working.

When it comes to the support from the IT-department towards the doctors when the system is failing, the subjects points out that it takes quite a while before larger or smaller problems gets solved. The lack of promptly problem-solving and support from the IT-department makes the specialists feel inadequate in their workflow, as they themselves cannot repair software-issues and the workflow gets interrupted.

There are of course that newly educated doctors that can more easily learn the hospitals patient-administrative systems as part of their education, which in turn gives them easier possibility to view and use the digital images and their description. The knowledge about the hospitals courses is varying among the subjects. This led to some of the interviewees being “self-taught” in the use of the systems with the aid of colleagues. On the other hand the subjects do not feel the need to be a “super-user” of the software, which is something they feel the radiologist should be.

The opportunity to view other hospitals digital images in a safe and user-friendly way, sits high on the specialists wish-list and this option is under development. As of today, if one needs to view images from another hospital, then one need to order the images, burn them onto a disc, send them with a courier service, then download them into the systems at the hospital. Even after all this it is not sure that the images gets into the system in an orderly safe way, which is necessary in order to view the course and progress of a disease. The subjects felt that speeding up this process and getting this in place would save a lot of time and resources.

# 7 Analysis

The gathered material is analysed with the aid of organisational theory and the theory of competency traps. The new digital technology in radiology, affected both the formal and informal element of the department that I studied. The first two sub-chapters will shed light on the changes in the formal element of the hospital and department. This consists of the organisational goals, strategies, structure, tasks performed and the technology used. In the last two sub-chapters I will describe the changes in the informal element in an organisation, or the lack of there. I will make an analysing of how the department's physicians' culture and behavioural processes has been affected as a result of the implementation and use of digital radiology below .

## 7.1 Tasks, technology and/or goals and strategy

Technically one can view the implementation of digital radiology as a revolutionary change. Close to 80% of Norwegian hospitals has implemented this new technology just four years after the implementation into use (Kjekshus&Bernstrøm, 2009). Most of the Norwegian hospitals can now be viewed as “free” from the radiological images on film.

The goal with the implementation of PACS (look in ch. 2), was to streamline the resources. In the note from the commissioner to the city council, it was presented that by using the digital radiological solutions, it would eliminate the need of regular radiological film, physical storage space and personnel resources. The new technology would allow viewing, storing and sending of the images via computers in a new network system. This would in turn improve the treatment-options, enhance patient-safety and the flow of information. In addition it was estimated that it would make treatment both faster and more effective (Helsedirektoratet/KITH, 2005).

Following this, the hospital and the department goals changed. The chosen strategy was to digitise the radiological solutions at the hospital. The new technology was implemented and this brought with it changes in the routines for the physicians at the department. Considering this, there is still no major change visible in the working day for the physicians. The interviewees states as follows:

*“Our working day has not changed in any major capacity. I believe that the changes are more visible for the secretaries, as they earlier had to go and physically pick up the images, now we just get them directly up on the screen ourselves.”*

*“There has been no change in my working day since I started working (as a doctor just under ten years ago). But it might be a bit more paper pushing nowadays.”*

*“At all wards ... (in different hospitals in Norway), the working day for the physicians has more or less been the same.”*

It appears that the main working plan is more or less the same as it was before the digitalisation. A closer view on the tasks and what they consist of, confirms that the physicians performs the same tasks as before. The signs that changes have taken place during the digital implementation only comes into view when you study how the physicians performs their tasks, or to put it in a more accurate way, which tools they use to perform their tasks as stated below:

*“In order to be able to view the radiological images, one must log onto a computer and open an electronic patient journal.”*

After the hospital introduced the digital displaying of images showing the various findings from the radiological examinations, this department went quite quickly from using plastic images to exclusively using digital displays. Now, all doctors could look at a single image separately, as they used to, but at the same time, the image is always available by logging onto the electronic patient record (EPJ). The software allows the doctors to check the images in different ways and thus they can make their own conclusions in addition to description made by a radiologist.

The specialists at the ward expressed a distinct view that the digital system at the hospital is far from perfect in its current form. But, regardless of the faults connected to PACS, EPJ and technical support which I will discuss later on, the physicians are still able to express their satisfaction of having radiological images in digital format. Expressed as follows:

*“I think that it is a definitive plus that we have the images on the computer.”*

*“I feel that it is an advantage to have access to images when I have time and it suits me. I notice that I am viewing more images now, compared to the time when the images were on film, which is due to the simplicity involved in accessing them.”*

Radiological images have become almost fully accessible for physicians via computers. This availability has affected the organisational structure regarding task management and

coordination and is facing further changes when the remaining software-developments is implemented. I will discuss this further in the next sub-chapter.

## 7.2 Organisational structure

The formal structure in a department can be viewed in the way distribution and coordination of tasks happens and also through the way of managing and controlling the organisation (Jacobsen&Thorsvik, 2007, p. 352).

Health professionals cooperate closely and have a clear-cut task distribution. The way digital radiology has been taken into use by the physicians has changed the distribution of tasks between the different groups of health professionals. The secretaries have experienced the largest changes compared to physicians when comparing tasks. The digitalisation of radiology means that the medical secretaries are no longer needed in the logistics of images back and forth to the physicians. We can now state that the physicians have obtained full control over the radiological images taken in the hospital.

*Quote:*

*“Earlier you (medical secretaries, nurses or the physician himself), had to physically go and fetch the image from the radiology department in order to view it. Now you can find it on the computer in this room.”*

The digitalisation has brought with it a streamlining of the work of both the physicians and other health professionals. It became easier to control the work process for the specialists and all others that assist them in the tasks of examining and/or treating patients.

*“Earlier (in the period of X-ray photography on film), it was often the case that images were missing and we had to go look for the images, and somebody had to go and fetch the images at the radiology department. It is a great advantage that we now can get the images we want to view direct on the computer-screen. It saves us a lot of effort. Often the examinations had to be postponed due to the fact that we had to wait for the images. This had a negative effect on physicians, other health professionals and the patients themselves”.*

On the other hand one can now define new causes of delays and stoppage of work than what was the norm prior to digitalisation:

Firstly; The physicians' lacks control over the progression and flow of requisitions, which can cause that the patients are not taken to the radiology department in order to produce an image. The reason for this is that it is still needed to take a requisition form of paper to the radiology department by the medical secretaries, nurses or physicians themselves in person.

*Quote:*

*"You still do not know when it (the requisition) is delivered and if the secretary remembered to deliver it to the radiology department. I (the physician) normally deliver them myself so that I know that they have been delivered"*

Secondly; The physicians has not acquired full access to all radiological images. This applies to images taken in other Norwegian hospitals, which the physicians needs to view when new not local patients is sent to their department for treatment. This require that another person must get a CD disk with the digital images, upload them into the hospital computer-system so that the physician has an opportunity to study them on a computer. This is time consuming, unpredictable and not secure.

*"... the process of getting the images from other hospitals may easily take up to a week. Because the image has to be transferred to a CD, and then sent by courier to this hospital, and then finally it can be transferred into the EPJ here."*

Radiological images are only a means of visually displaying a particular part of the patient's problem that then needs the professional doctor with the right competence to both interpret and to use it as additional information for report and treatment. The task of distribution between clinicians and radiologists is that radiologists should know maximum about the interpretation of the image while the clinicians make use of the interpretation to form a complete picture of the patient's condition. This was the case with radiological images on film, and it continues the same way after the digitalisation of radiology. This distribution of tasks takes place as follows: The requisition of a radiological examination must be written by clinicians so precise and clear that the radiologist can take the image correctly and of the correct area. Moreover, the radiologists must accurately describe the images and their details and the clinicians find these detailed descriptions in the EPJ system. If anything is unclear, the clinician can make a call to the radiologist and get clarification. It still is, however, the radiology meetings that are the primary means of communications between these two specialist groups.

*“It is the two-way communication that is the key. We can discuss directly with the radiologist the detailed findings in the images. The description is for the most part not as good as the discussion we have with the radiologist, and we get to know if these are confirmed finds or not – what the finds mean we can figure out in plenum...”*

The flow of information, its quality and speed is valuable to both the physicians and other health professionals. It is however, not the pure flow of information that is the most important part of the reasons that the physicians listed when they refused to abolish the radiology meetings.

*“The administration discussed abolishing the radiology meetings around the time when the digital radiology was implemented,. The thought behind this is that as the physicians can view the images via the computer, the need is not as great as it was before to demonstrate the images in the radiology department. Their view is that the physicians could have had patients during that time – economically viewed.”*

I will discuss the various aspects related to the need for a radiology meeting in the next two sections relating to the organisational culture and the behaviour of the physicians.

Now I will direct my attention to the technical issues, which in my opinion has contributed a part in why the implementation of digital radiology had so little effect on the working day of the hospital physicians.

### **Further development and technical problems**

Digital radiology is not just about that the images being shown in digital format. The technology consists of several elements and when these are implemented and working properly, one can begin to talk about the benefits as a result of the use of the new technologies. The elements I am referring to is the availability of computer software programs that should function continuously, get the option of multiple computer screens that allows for splitting text and images, functionality of the EPJ including the option of sending the requisition for radiology examination directly to the radiology department. All of this was mentioned by the doctors on the ward as technological solutions they expected to work better in the future. They were not happy with the functionality when I interviewed them. It also proves that digital radiology cannot be considered as a single technology, but must be seen in conjunction with other technologies, the development of technologies and technical support.

It seems that the physicians have a sufficient number of computers to gain access to images. However, it is not completely accessible regarding the viewing opportunities in their offices. This is how the interviewees talk about their situation having two monitors but only one of them work:

*“Earlier both monitors installed in the office worked. Then we could watch two different things simultaneously. It was intended that you could view the radiographs on one monitor while you were consulting the medical records on the other. Now you have to look at one thing at the time, and that’s that. This makes it difficult and time-consuming to summarise i.e. a ten-day stay with multiple examinations, it is a lot of scrolling and searching and such.”*

One of the most frustrating parts for the physicians and the largest hindrance in performing their profession is when the software stops working and the computer fails.

*“It is rather frustrating when the program says the image is uploaded, but the screen is black.”*

*“the computer freezes – then we’re stuck... at that point we are helpless.”*

*“It (computer) is often down, it crashes often, and it may be down for several hours. It is hopeless if you are at the outpatient clinic...”*

It turns out that when problems arise concerning the computers, it is time-consuming to obtain the necessary technical assistance.

*“If there are problems regarding the use of programs, it is difficult to get help to solve them. It generates a lot of frustration... it is as slow as molasses sometimes and it makes you want to cry! We, the physicians, are not able to fix the faults.”*

It is these cases that often happen that physicians talk about many times during the interviews, this makes it clear how vulnerable the digital technology and digital radiology is. But from the physicians view when they experience a partial or full stop in their work, and although the personnel providing technical support work hard, the physicians perceive that the time used to fixing the problems, is taking too long, because it should never have happened.

As a summary to this section, I would like to say that the change in the department’s formal structure occurs slowly. Partly it may be due to the imperfection in the solutions within digital radiology that the hospital has implemented, since there are several technical solutions that have to be resolved before this technology evolves to something that will radically change the working day of the physicians in their own eyes. The second part comprises the



less visible. Here I mean that physicians, as a research group, their cultural and behavioural aspects, play a major role in the minimal effective force that digital radiology has influenced the physicians working day. This I shall discuss in the next section.

### 7.3 The organisations' culture

The term organisational culture is a complex one. It is still possible to highlight the basic elements, which in turn allows us to study, as in our case, the departments and physician's culture and the change that has occurred. As I presented the numbers in Figure 1, the cultural dimension covers values, norms, basic assumptions and artefacts (Jacobsen&Thorsvik, 2007, ch.4). Here I would like to discuss the effect that digital radiology may have had on the first three components. I will analyse in the last chapter the behaviour of the physicians, which is a part of the physicians' artefacts.

A basic assumption related to the implementation of a new technology in general and digital radiology especially, was described by one of my interviewees during the interview:

*“One gets such high hopes for this new digital system, and when it turns out that it isn't as good as one thinks, one gets frustrated. One expects that things are going to become easier, but that does not happen. It did improve, of course it did.”*

This can explain the lack of correlation between the hopes for the digital radiology that the physicians had during the transition to the new technology and how in reality the technology works and what it brings. Here is another quote describing this situation:

*“The first impression after the implementation of digital radiology is very good By the fact that we now have the images on our computer screens. Unfortunately, we had screens with low resolution earlier. . This has improved greatly.”*

It was clear both during observation and under the interviews that the physicians could not imagine going back to a time without the computer and digital images. I would say that the change has developed a digital culture among physicians. The fact that you now view the images on a computer screen is now seen as an obvious progress. The physicians learn different short cuts so they can perform their work in an optimal way using the hospital software solutions.

*“I am not satisfied with the system (the concrete electronically solution including EPJ, PACS and the like), but you get used to it...”*

The specialists inform as well that they would like to attend a course in use of the hospital PACS. On the other hand, it did not seem problematic for the departments' specialists to teach themselves without formal help, i.e. just self-teaching and tips and tricks from colleagues. They seemed adequate regarding the use of computers. This can very well be because Norway as a nation is prominent in the IKT field. Although doctors master software programs well enough to perform their work, they are quite unhappy that the necessary solutions are still not in place. This leads to more work, but not "double the work", as I assumed in my theory chapter. It has nothing to do with working with both X-ray photography on film images and digital, but more a case of having many issues at the same time. The new technology is still imperfect, so the physicians must keep constant control and create an overview of what is still needed to be documented on paper, and what needs to be ordered electronically. I consider this as one of the aspects of resistance to change in the daily schedule of physicians, and also the reason for a lack of initiative to change. The next aspect affects the social side of the physicians work.

The computer usage is at a high level in the department where I conducted my study. The computer is used by the department-specialists, among other things, to study the images as the main tool in the strategy of evaluation. The physician spends a lot of time on his own in front of the computer in order to perform his work, and this has a negative effect on the direct contact with other health professionals. This is why the physicians among other things thought it valuable to maintain the get-togethers they have, in order to interface with their colleagues in the department and other medical staff at the hospital within one working day.

*"There (at departmental meetings) one sees everyone gathered... this is important both socially and academically."*

*"The radiology meetings are the only contact we do have with the radiologists, and then we also get to know which radiologists that normally study our images."*

The need for social and academic contact for the physicians is satisfied via different meetings in between themselves at department meetings and at a string of other meetings, among those, the radiology meeting and the lunch meeting. This is one of the reasons that the suggestion from the Administration board on abandoning the radiology meetings were voted down by the physicians.

It may be debated that the physicians ended up in a situation that March calls competency traps. The specialists are already so satisfied and used to the way they now work regarding the use of digital radiology, that they fail to see a better way to do and/or organise their working day. Benefit realisation as a result of digitalisation of radiology does not happen in the full extent as there is no room in the hectic day of a physician. This is a combination of multiple things. First, they have a hectic day and have not the time to sit down and figure out a better way of doing things. Second, they are set in their ways from the days they worked with the films and are happy with the working order from those days. It may be that the specialists lack the overall overview of the different ways to accomplish the same result, as this have the potential of seeming like competing with their set way of organising their present working day. It seems to me that the management has failed to communicate their point of view/vision of the new working day to the physicians, based on the use of digital radiology.

*“The goal, I think of implementing and using digital radiology was economical. But I am not sure of their thinking. Savings? At the radiology department one saves storage space, saves on secretary aid, I would think. There are far fewer medical secretaries, but that might correlate to the fact that we started up with voice recognising programs at the same time, or perhaps later the same year. It is difficult to know why something happened, and which processes influenced that process.”*

In the last section I will have focus on the communication as a part of the professional behaviour.

## **7.4 Behavioural processes**

As Jacobsen and Thorsvik describe in their book (Jacobsen&Thorsvik, 2007, p. 352), the changes in behavioural processes span the change of production, communication, decision-making, internal power relations and learning.

It was mentioned in the text above, that specialists are on the way of developing or that they already have developed a digital culture as a result of the large percentage of the tasks being performed on the computer already. When the interviewees talked about radiology the digital images was seen as an indivisible part of their professional world. The increased availability of the images meant that they have begun to see a larger quantity of images then what was the

case in the days of the images developed on film. The specialists feel that this strengthens their knowledge in radiology and have a positive impact on assessment and treatment.

*“Diagnostics have improved. As the improved availability of images has a direct impact on the diagnostic work. It may well be difficult to document this, but my personal opinion is that this gives an improved diagnostics. We have the images available at any time, so we can go look at the images, get some more information from the patient, go back and view the images again, there is better communication between image diagnostics and clinical data. All of this gives a better diagnostics, I think”*

*“In a day I normally open the EPJ in between 10-20 times...”*

The digital technology triggered a new pattern of behaviour where physicians began to study the images more often than what they feel was the case before. This makes it possible to assume that the productivity of the specialists have increased as well. At least in terms of better knowledge about the conditions viewed by themselves on the images, or in plenum in radiology meetings. This in turn means a more efficient assessment process. In other words, it is likely that the physicians' productivity may have increased as a result of the digitalisation of radiology.

I have mentioned several times that the physicians work depends on good and speedy communication, both between themselves and with other professionals. The interviewees believe that the organised access to the electronic images has stimulated and increasing the number of spontaneous scientific discussions, as it is so easy to obtain the necessary information, including the radiograph, it's description and other relevant information they might need from the EPJ.

*“Communication between physicians at the department might have improved somewhat. We discuss patients more often now during our lunch meetings, as we have the option of producing the images at once without waiting until the next morning in order to view the images again.”*

The need for contact with the radiologist is roughly the same now, as it was before the digitalisation of radiology. The radiology meetings are more than just an image show. It is a venue for academic discussion, a social element as well as a teaching tool.

*“They (radiology meetings) are perceived as valuable. It is important to have a forum for discussion directly with a radiologist. Not just by phone or something. Having an open group discussion is important both for the individual patient and in terms of*

*educating new doctors. We are an educational institution here and then we have a place where you can discuss the radiology clinic.”*

*“...radiology meetings are helpful for us that still have the feeling that radiology is a bit challenging.”*

Lindsay and her colleagues found that the increased availability of radiologists for direct consultation was the only factor that were statistically significant associated with the clinicians' satisfaction regarding radiology services, Petter Hurlen writes in his article, “Teleradiologi, muligheter og utfordringer”, for the Journal of the Norwegian Medical Association (Hurlen, 2012)

Digital radiology images can be viewed as a new source of learning. The communications has improved. It is still the same means of communication as before digitalisation.

Physicians have been given better access to images of a quality that does not deteriorate, and thus have influence over when and how many images they want to study. They have become less dependent on certain types of health professionals as medical secretaries and archivists, all the while the IT department has received a considerable control over the physicians working tools and thus their work.

## 8 Summary

This study aimed to investigate whether the introduction and use of digital radiology in a department at a Norwegian hospital has led to changes in the working day of physicians. The material was analysed using organisational theory that also included March's theory of competency traps and Røviks' theory of the hospitals' multi-standard organisations.

The formal element of the department as part of the hospital has been affected in terms of adjusting the way and the choice of digitalisation strategy.

Digital radiology is much sought after and frequently used by the physicians in the department and contributes to the development of a digital culture in the physicians. It has become an indivisible part of their everyday lives while the working day has not been greatly affected by the introduction of the new technology. Physicians have gained almost complete control and continuous access to the results of various radiology examinations and findings. Nevertheless, specialists do not need to change the current layout and reap all the rewards that the digital radiology has the means to give. This may be in part because the technology itself is still under development. This does not mean that all its components are working properly as there are parts that still need time in order to be implemented/upgraded. In addition, it may be the results of competency traps combined with imperfect communication between the physicians and the hospital management. The latter has its roots in the medical culture and behaviour that the specialists have developed through their education and work. It will take more time to affect and/or change this and the informal part, than to change the formal part of the department.

However, it is possible to see the slow and steady process towards change of control, the internal power relations and to some extent, the signs of reorganisation after the introduction of digital radiology. Physicians have become major consumers of technical support in order to have an opportunity to perform their duties. This led to a revitalisation of the IT department, and this led to the fact that the IT department has become a stronger and more influential player in the hospital structure. Their work has a strong influence on the physician's daily work in the use of digital solutions for radiology, and also for the application of other computer technologies.

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# Appendices

## **Appendix I: Information and consent to the participants in the interview**

**Master student** – Julia Lützen, Master’s Degree Programme in Health Economics, Policy, and Management, University of Oslo

In connection with the survey based on the thesis on how digital radiology affects the development of hospital organisation, arises a need to conduct interviews of physicians at a ward at Oslo University Hospital. The interview questions will cover the following fields:

- A normal working day for the physicians at the chosen ward, before and after the introduction of digital radiology.
- Personal opinion and experience in relation to the use of digital radiology in everyday live and the changes it brought with to the physicians at the ward.
- Desired changes in the use of digital radiology for it to function in the best possible way for physicians, ward and hospital.
- Barriers in the use of digital radiology.

The term “digital radiology” is used to denote all the new computer-technology in radiology at the hospital (digital image viewing, digital image archives, tele-radiology etc.).

**The length of the interview:** The interview will take between twenty to forty minutes.

**Confidentiality:** The interviewee is anonymous. The interview will not be published in its entirety, only parts of the interview will be used in the thesis, without reference to the interviewee. The interviewee will have an option to not answer any questions and to withdraw from the interview along the way, included information given earlier. There is no need to give any reason for this.

**Storage of the interview:** The interview will be recorded and transcribed into text. All audio files will be deleted after the thesis is submitted to the examiners at the university.

**Contact:** For questions, contact Julia Lützen by phone [REDACTED] or by email:

[REDACTED]

**Consent:** If you consent to participate in the interviews under these guidelines, I want you to either send me an email to confirm, or by signing this document before the conduction of the interview.

## **Appendix II: Interview guide**

Terms used in this interview guide:

Digital radiology – Includes all new computer technology within radiology that are in use in hospitals (digital image viewing, digital image archives, tele-radiology e.t.c).

Tele-radiology – transfer of radiological image-material from one location to another for scrutiny and consultation (Aslaksen, Pedersen, Marthinsen, Kløw – Teleradiologi i Norge, nr. 9-10 – 20. 05.2011 Tidsskrift for Norsk Legeforening 2011; 131-931).

1. How is a normal working day for a doctor here at this ward?

- What kind of meetings does he/she attend (meetings in the morning, radiology meetings etc.)?
- What tasks has to be performed during a working day?
- Which computer systems are used by the physicians in the course of a working day?

2. If you previously worked without digitalisation of radiology examinations, how was the working day organised then?

3. Has anything in your opinion changed, after the implementation of digital radiology?

- Your working day?
- Routines at the ward?
- Organisation at the hospital?

4. What was your first impression when you started using electronic radiological image archive attending meetings where the images were viewed electronically, possibly using tele-radiology etc.?

5. How do you feel about it now?

6. Is it something you feel should be changed in relation to the use of digital radiology so that your working day, routines, organisation at the ward and/or hospital would improve?

- If yes, what specifically should be changed?
- How would you change it?

7. Is there anything that you think is hindering new technologies within the field of radiology from being taken into use at your ward at the hospital?